Curriculum Vitae

Personal Data

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Education

1993-2000 Ph.D. Physics,
Carleton University (Received January, 2000).
Supervisor: Prof. D. Karlen
Thesis title: *A Study of Decays of the Tau Lepton with Charged Kaons*

1991-1993 M.Sc. Physics,
University of Victoria.
Supervisor: Prof. D. Pitman
Thesis title: *A Measurement of the* $\tau^- \rightarrow \mathrm{K}^-\nu$ *Branching Ratio using the OPAL Detector at LEP*

1985-1991 B.Sc. (Honours) Physics,
Simon Fraser University.

Academic Awards

May 2000	*Carleton University Senate Medal* for outstanding achievement at the doctoral level
Sep 1993 to Sep 1995	*NSERC Doctoral Fellowship* (Carleton University)
May 1991 to Sep 1991	*NSERC Undergraduate Research Award* (University of Victoria)
Jan 1991	*Putnam Mathematics Prize* for placing in the top 100 on the Putnam International Mathematics Prize Exam (Simon Fraser University)
May 1990 to Sep 1990	*NSERC Undergraduate Research Award* (University of Victoria)
May 1989 to Sep 1989	*NSERC Undergraduate Research Award* (TRIUMF)
Sep 1988 to Dec 1988	*M. Lawson Scholarship* for academic achievement (Simon Fraser University)
Sep 1987 to Dec 1987	*M. Lawson Scholarship* for academic achievement (Simon Fraser University)
Sep 1985 to May 1986	*President's Scholarship* for academic achievement (Simon Fraser University)

Research Experience

Sep '00– **Research Associate, State University of New York at Stony Brook**
Run II of the Tevatron $p\bar{p}$ collider began in March 2001. The center of mass energy of the $p\bar{p}$ collisions in Run II is the highest yet achieved, and presents a rich physics program centered around high p_T physics, such as studies of the properties of the top quark, and low p_T physics, such as the study of the properties of B mesons. As can be seen from my list of service work below, I have been an active participant in both the low p_T and high p_T physics programs at DØ. However, my physics studies at DØ have been most recently centered upon searching for the B_c meson, which has yet to be observed by any experiment in a fully reconstructed final state. In recent months the DØ experiment has collected a large enough data set to make the observation of this meson in the fully reconstructed $J/\psi\pi$ and the partially reconstructed $J/\psi\mu\nu$ final states feasible. The initial phase of this analysis is currently being prepared for presentation at ICHEP'04.

Key to the success of this analysis, and to the success of nearly the entire Run II physics program at the Tevatron will be the ability to select events containing b-quarks efficiently and cleanly. Due to the long lived nature of B hadrons, events containing b-quarks typically contain a number of charged particles that are displaced by roughly a few hundred microns from the $p\bar{p}$ interaction point. Separating such events from the almost overwhelming light quark production background (which typically contains far fewer displaced charged particles per event) requires the ability to precisely measure the trajectory of the charged particles produced in each event. My duties at Stony Brook have concentrated on virtually all aspects high p_T and low p_T b-tagging at the DØ experiment, including:

Alignment of the DØ silicon microvertex detector: The DØ silicon microvertex detector (SMT) lies close to the beam pipe and is designed to precisely measure the positions of charged particles, with a design resolution of approximately 50 microns (the resolution strongly depends on the p_T of the track). However, when Run II first began the measured resolution was approximately 70 microns and was dominated by mis-alignments of the elements of the SMT. During my first 18 months at DØ I worked with the alignment group, developing the code infrastructure and algorithms used to align the SMT. In March of 2002, the first pass of the alignment was performed, and the measured resolution is now very close to the ideal.

Vertexing: Vertexing algorithms will be a key component in the arsenal of tools used to identify events containing b-quarks. During the summer of 2002, I developed a vertexing package that allows the application of all possible topological and kinematic constraints to a decay chain. Application of such constraints can dramatically reduce the vertex decay-length and momentum resolutions at DØ by a factor of two or more. This package is currently being used in a number of analyses by the DØ B-physics group.

The package is completely general, is accompanied by extensive documentation of the code and methodology, and is applicable at virtually any high energy physics experiment with a tracking chamber in a solenoidal magnetic field. The developers of the ROOT physics analysis package are interested in having such a general vertexing tool as part of their package, and thus this code is slated to be integrated into the standard ROOT release in the near future.

b-tagging: Between 2002 and 2003 I was active in the DØ b-tagging group, performing detailed comparison studies of various tagging algorithms, and developing new tagging strategies. Studies I performed indicated that the significance of many analyses could be dramatically improved through the development of b-tagging algorithms specifically designed for each particular analysis. For some analyses, such as searches for the Higgs boson, the improvement was equivalent to nearly doubling the size of the data set. The studies are described in a DØ internal note, and this ansatz for improvement is now being applied to a number of top quark analyses at DØ.

Between 2002 and 2003 I was the convener of the Higgs b-tagging group. I co-ordinated the efforts of several graduate students and postdocs, and produced a unified interface to several different b-tagging algorithms for use by Higgs group members in the 2003 Higgs search analyses. I also produced a DØ internal note describing the relative performance of the tagging algorithms to which the package interfaced.

Multivariate techniques: Extracting the best discrimination between b-quark and light-quark jets in the dense track environment of Run II events will likely require sophisticated multivariate techniques. During the past three years I have designed and developed the Fermilab Multivariate Analysis package, TerraFerMA. TerraFerMA acts as a user-friendly, global interface to many disparate multivariate techniques and packages, and includes many helpful analysis tools to aid users in sorting discriminators. I have had three graduate students and a postdoc working under my supervision on this project. Ter-

raFerMA was made public early in 2002, and has developed widespread interest in the physics community. I am currently collaborating with the developers of the ROOT physics analysis package to include TerraFerMA as a standard addition to future releases of ROOT. TerraFerMA has extensive associated documentation and is publicly available for use by physicists in experiments world-wide off of my DØ web site.

I have been active on other fronts during the past three years. Between 2001 and 2003 I was the co-convener of the DØ ZH working group, charged with co-ordinating Higgs boson search analyses in the ZH$\rightarrow$ l^+l^-+dijet channels. In this role I co-ordinated the work of several graduate students and postdocs in developing the first DØ analyses of these search channels.

I am frequently invited to speak at conferences, workshops and at universities on the subject of multivariate methods and advanced statistical data analysis techniques. I have been active in the development of new advanced statistical data analysis tools for use in particle physics. There is a pressing need for such tools to make the most of the data collected by increasingly complicated (and expensive) particle physics experiments. There are currently very few physicists in the world who have enough programming experience and broad enough experience with multivariate methods to undertake this much needed service to the global particle physics community. In addition to my work on the TerraFerMA package, I have also developed a novel kernel probability density estimation method specifically designed for use in particle physics analyses. An independent publication describing the method is being written. I have also developed de-convolution tools and methods for use in particle physics analyses. These are described in an internal DØ note.

In addition, I recently collaborated with a number of people from the MAGIC Cherenkov gamma-ray telescope collaboration in a comparison study of multivariate methods. The studies resulted in the paper that was recently published in Nuclear Instruments and Methods.

Jan '00–
Sep '00

Research Associate, Carleton University (OPAL experiment)

Many extensions to the Standard Model predict the existence of more than one Higgs boson. One of the more popular examples of such a model is the Minimal Supersymmetric Extension to the Standard Model (MSSM). The MSSM predicts 5 Higgs bosons, two of which are charged. The couplings of the charged Higgs bosons to the fundamental fermions are proportional to the fermion mass, thus the Higgs preferentially couples to fermions in the second and third quark and lepton generations.

During my short postdoctoral term at Carleton University, I worked on an independent project to set limits on the mass of the charged Higgs boson using decay properties of the charged kaon and the tau lepton. These studies resulted in one of the most stringent indirect limits on the $\tan\beta/m_{\mathrm{H}}$ parameter space yet achieved. Use of these decay channels to set the limit involved extensive development of the phenomenology of charged Higgs effects in interactions involving kaons. These studies resulted in a paper submitted for publication.

Sep '93–
Jan '00

Graduate Student, Carleton University (OPAL experiment)
Supervisor: Prof. D. Karlen

The tau lepton provides an excellent laboratory for studying many aspects of the Standard Model, because it (alone among the leptons) is massive enough to decay to hadronic final states, allowing investigations of the weak hadronic current, and strong interaction effects. Tau decays with kaons in the final state, in particular, are sensitive to beyond-the-Standard-Model physics. My graduate work at Carleton included:

- Studies of tau decays with charged kaons in the final state at OPAL. The various branching ratios determined by these studies are either the world's best measurements, or contribute significantly to the reduction of the uncertainty on the world average of that quantity. In addition, the study of the resonant structure of three-prong tau decay modes with charged kaons is among the most comprehensive yet performed. The branching ratio and structure studies resulted in two publications in European Physics Journal **C**, and it was for this work that I was awarded the Carleton University senate medal for outstanding performance at the doctoral level.
- Development of a Monte Carlo generator to model tau decays with kaons in multi-meson final states. This software has since been included in the latest release of the Tauola Monte Carlo tau decay package.
- Precise calibration of the ionisation energy loss measurements of the OPAL detector.

Sep '91– Aug '93 **Graduate Student, University of Victoria (OPAL experiment)**
Supervisor: Prof. D. Pitman
• Monte Carlo studies and subsequent development of the prototype of the ATLAS accordion liquid Argon calorimeter. These studies resulted in a publication in Nuclear Instruments and Methods.
• Studies of one-prong tau decays with a charged kaon in the final state using data collected by the OPAL detector.

May '91– Aug '91 **Research Assistant, University of Victoria (ATLAS experiment)**
Supervisor: Prof. M. Lefebvre.
• Monte Carlo studies of the prototype of the ATLAS accordion liquid Argon calorimeter.

Jan '90– Sep '90 **Research Assistant, University of Victoria (OPAL experiment)**
Supervisor: Prof. R. Keeler
• Monte Carlo studies of the OPAL silicon vertex detector.

May '89– Sep '89 **Research Assistant, TRIUMF Positron Emission Tomography Group**
Supervisor: Prof. R. Harrop.
• Monte Carlo studies of a PET scanner prototype.

Service

I currently serve on three editorial boards at DØ (two are reviewing Run I analyses, and the other is reviewing the DØ Run II $t\bar{t}$ cross-section analysis). As a member of the OPAL collaboration I served on three editorial boards, and in February 2004 I also refereed a paper appearing in the IEEE Transactions in Nuclear Science publication.

Other past service work includes:

Sep '02– Jan '04	Member of the DØ tour area committee, charged with developing displays at DØ directed at the general public. The DØ display this committee developed opened to the public last year.
Jan '02– Jan '04	Appointed member of the Fermilab training committee, charged with developing academic and technical training programs for Fermilab users.
Aug '02– Aug '03	Convener of the DØ Higgs b-tagging group, charged with developing b-tagging algorithms optimized for Higgs boson searches.
Aug '01– Aug '03	Co-convener of the DØ ZH working group, charged with co-ordinating Higgs boson search analyses in the ZH$\rightarrow l^+l^-$+dijet channels.
Sep '01– Sep '03	Elected member of the Fermilab Users' Executive committee (UEC). Between September 2002 and September 2003, I was the chair of the UEC lab-wide quality of life committee. I also actively participated on other UEC committees, including the outreach committee, charged with developing novel means to generate public interest in Fermilab and its associated physics program. As a member of the UEC I also visited Washington, D.C., to lobby the Senate and Congress for increased funding for the physical sciences. I met with a number of state representatives as part of this effort.
Jun '01– Aug '03	Member of the DØ offline resources board, charged with allocation of computing resources within the DØ collaboration.
Jun '01–	Member of the DØ web resources committee, charged with developing web resources directed both at DØ collaborators and the general public.
May '01–	Co-chair of the DØ quality of life committee, charged with improving the working conditions at the DØ experiment.
Sep '96	While at Carleton University I collaborated with scientists from across Canada to lobby the Canadian House of Commons for increased funding for fundamental scientific research in Canada.
Sep '88– Sep '91	President, Simon Fraser University undergraduate physics society.

Teaching Experience

As a graduate student and postdoctoral research associate I have amassed extensive teaching and mentoring experience. I enjoy interacting with students from many levels; from elementary school to graduate students. The many students from many different universities and institutes who repeatedly seek me out for help and advice indicates that they also enjoy interacting with me.

Dec '00–	I have supervised three graduate students working on the implementation of the TerraFerMA multivariate analysis package, and also advised three other graduate students from a number of institutes developing b-tagging algorithms for multi-b-jet analyses. I have also mentored other DØ students, including students working on Run II Higgs topics, and students working on RunI top-quark dissertations.
Jan '98– May '00	During my sojourn at the University of Pennsylvania I worked for a private tutoring agency. I tutored college students in a variety of math and science subjects, including civil engineering, calculus, and physics.
Jan '98– May '99	Teaching assistant for undergraduate physics courses at the University of Pennsylvania.
Sep '94– May '97	Teaching assistant for undergraduate physics courses at Carleton University.
Sep '93– May '97	I had a private tutoring business while I was a graduate student at Carleton and I tutored high school and college students in a variety of subjects including algebra, calculus, physics, and chemistry.
Sep '91– May '92	Teaching assistant for undergraduate physics courses at the University of Victoria.
Sep '89– May '91	Teaching assistant for undergraduate math and physics courses at Simon Fraser University.

Conferences / Summer Schools

- *PHYSTAT: Statistical Methods in Physics Workshop*,
  March 2004, Michigan State University.
- *Lepton Photon*,
  August 2003, Batavia, Illinois.
- *Advanced Statistical Techniques in Particle Physics*,
  March 2002, Durham, England.
- *University of Chicago Linear Collider Workshop*,
  January 2002, Chicago, Illinois.
- *Snowmass 2001*, July 2001, Snowmass, Colorado.
- *APS Division of Particles and Fields Meeting*, August 2000, Columbus, Ohio.
- *American Physical Society Centennial Meeting*, March 1999, Atlanta, Georgia.
- *Fourth Workshop on Tau Lepton Physics*, September 1996, Estes Park, Colorado.
- *Eighth NATO Advanced Study Institute*, "Techniques and Concepts in High-Energy Physics", June 1994, St. Croix, U.S. Virgin Islands.
- *Congress of the Canadian Association of Physicists*, June 1993, Vancouver, Canada.
- *Beyond the Standard Model II*, October 1990, Norman, Oklahoma.

Seminars and Presentations

- **The TerraFerMA Multivariate Package**,
  invited presentation, PHYSTAT: Statistical Methods in Physics Workshop, Michigan State University, March, 2004.
- **Making the Most of your Data**,
  invited seminar, Purdue, March, 2003.
- **Data Mining in High Energy Physics**,
  invited seminar, University of Toronto, November, 2002.
- **On the Road to the Higgs: Learning to Walk Before We Run**,
  invited seminar, University of Notre Dame, November, 2002.

- **The TerraFerMA Multivariate Package**,
  invited presentation, ROOT Workshop, CERN, October, 2002.

- **The TerraFerMA Multivariate Package**,
  invited presentation, Fermilab Advanced Analysis Group, May, 2002.

- **Overview of Probability Density Estimation Methods**,
  Advanced Statistical Techniques in Particle Physics, March 2002,
  Durham, England.

- **Benefits of Minimizing the Number of Discriminators Used in a Multivariate Analysis**,
  Advanced Statistical Techniques in Particle Physics, March 2002,
  Durham, England.

- **Overview of Multivariate Techniques in High Energy Physics**,
  invited seminar, Rice University, November, 2000.

- **Strange Tau Physics**,
  invited seminar, University of Pennsylvania, May, 2000.

- **Charged Higgs Mass Limits from Kaon Decays**, APS Division of Particles and Fields meeting, August 9-12, 2000.

- **Tau Decays with Kaons at OPAL**, APS Division of Particles and Fields meeting, August 9-12, 2000.

- **Measurement of Triple Gauge Boson Couplings from W^+W^- Production at OPAL**, American Physical Society Centennial meeting, March 20-26, 1999.

- **The W^+W^- Production Cross-Section at OPAL**, American Physical Society Centennial meeting, March 20-26, 1999.

- **Three-Prong Tau Decays with Charged Kaons at OPAL**, American Physical Society Centennial meeting, March 20-26, 1999.

- **Tau Decays with Neutral Kaons at OPAL**, in the Proceedings of the Fourth Workshop on Tau Lepton Physics, September 16-19, 1996.

Non-Refereed Publications

- **Optimizing the Efficiency of Mass Constrained Vertex Fitting via a Track pT Uncertainty Scale Factor**, S.Towers, DØNote 4407, 2004.
- **The `btags_cert` CVS Package: A Uniform b-tagging Interface for DØ Analyses**, S.Towers, DØNote 4170, 2003.
- **Optimization of b-tag Operation Points: A Means to Dramatically Improve Signal Signficance in Multi-b-tag Analyses** , S.Towers, DØNote 4086, 2003.
- **A Simple Method to Correct Monte Carlo Smearing** , S.Towers, DØNote 4046, 2002.
- **Search Strategy for Initial Observation of Z$\rightarrow b\bar{b}$ Decays at DØ in Run II**, S.Towers, DØNote 4037, 2002.
- **Performance comparison of Impact-Parameter and Secondary-Vertex b-Quark Jet Tags in Data**, S.Towers, DØNote 4031, 2002.
- **Benefits of Minimizing the Number of Discriminators Used in a Multivariate Analysis**, S.Towers, DØNote 4027, 2002.
- **`vfitter`: A Vertexing Package with Kinematic and Topological Constraints**, S.Towers, DØNote 3994, 2002.
- **Statistical Uncertainties on the Elements of Correlation and Covariance Matrices**, S.Towers, OPAL Technical note TN631, 1999.
- **Monte Carlo Generation of Tau Decay Final States with Charged and Neutral Kaons**, S.Towers, OPAL Technical note TN613, 1999.
- **Determination of Tau Branching Ratios to Three-Prong Final States with Charged Kaons**, S.Towers, D.Karlen, OPAL Physics note PN304, 1997.
- **Identification of Charged Kaons in Three-Prong Tau Decays Using** dE/dx **and the Likelihood Method**, S.Towers, OPAL Technical note TN497, 1997.
- **Updated Optimisation of the OPAL Energy Loss Parameterisation to the Measured Energy Loss of Tau Decays**, S.Towers OPAL Technical note TN371, 1996.
- **Optimisation of the OPAL Energy Loss Parameterisation to the Measured** dE/dx **of Tau Decays**, S.Towers OPAL Technical note TN296, 1995.

Refereed Publications

I recently collaborated with a number of people in a comparison study of multivariate methods. The studies resulted in the paper:

- **Methods for multidimensional event classification: a case study using images from a Cherenkov gamma-ray telescope**, R.K.Bock *et al*,NIM A516 (2004), p511-528.

I have been a member of the DØ author list since September 2001. DØ publications with which I have been closely involved are:

- **Search for New Particles in the Two-Jet Decay Channel with the DØ Detector**, V.M.Abazov *et al* (submitted to Physical Review Letters).
- **Search for Narrow $t\bar{t}$ Resonances in $p\bar{p}$ collisions at $\sqrt{s} = 1.8$ TeV**, V.M.Abazov *et al* (submitted to Physical Review Letters).

My independent work on extracting charged Higgs mass limits from the decay properties of the charged kaon and tau lepton is described in the paper:

- **Charged Higgs Mass Limits from the $\tau^- \to \nu \mathrm{K}^-$ and $\mathrm{K}^- \to \nu l^-$ Branching Fractions**, S.Towers, hep-ex/0004022

A revised version of this meta-analysis that also includes the leptonic branching fractions of D mesons in the limit calculation has recently been submitted to the International Journal of Modern Physics, and is currently under review.

I was a member of the OPAL author list from May 1993 to March 2001. During that time the collaboration published over 200 papers in European Physics Journal **C**, Zeitschrift für Physik **C**, Physics Letters **B**, and Nuclear Instruments and Methods. OPAL publications with which I was closely involved are:

- **A Study of One-Prong Tau Decays with Charged Kaons**,
  OPAL collaboration, Eur.Phys.J.C19:653-665,2001
- **A Study of Three-Prong Tau Decays with Charged Kaons**,
  OPAL collaboration, Eur.Phys.J.C13:197-212,2000
- **Tau Decays with Neutral Kaons**,
  OPAL collaboration, Eur.Phys.J.C13:213-223,2000
- **Search for Unstable and Excited Leptons in e^+e^- Collisions at** 170 GeV–172 GeV **Centre-of-Mass Energy**,
  OPAL collaboration, Eur.Phys.J.C1:45-64,1998

- **Measurements of the Inclusive Branching Ratios of the Tau Lepton to K^0_S and Charged $K^*(892)$**,
  OPAL collaboration, Phys.Lett.B339:278-292,1994.

I am the primary author of the first two publications in the list, and I either acted as a referee for the remaining publications, and/or they made use of analysis techniques I developed during my doctoral studies. A full list of the OPAL publications is available on request.

During my master's studies I assisted in the design and study of a prototype liquid Argon calorimeter that has since been included in the ATLAS detector. The study of this prototype resulted in the publication:

- **Performance of a Liquid Argon Accordion Calorimeter with Fast Readout**, Aubert *et al*, NIM A321:467-478, 1992.

Statement of Research Interests

References

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